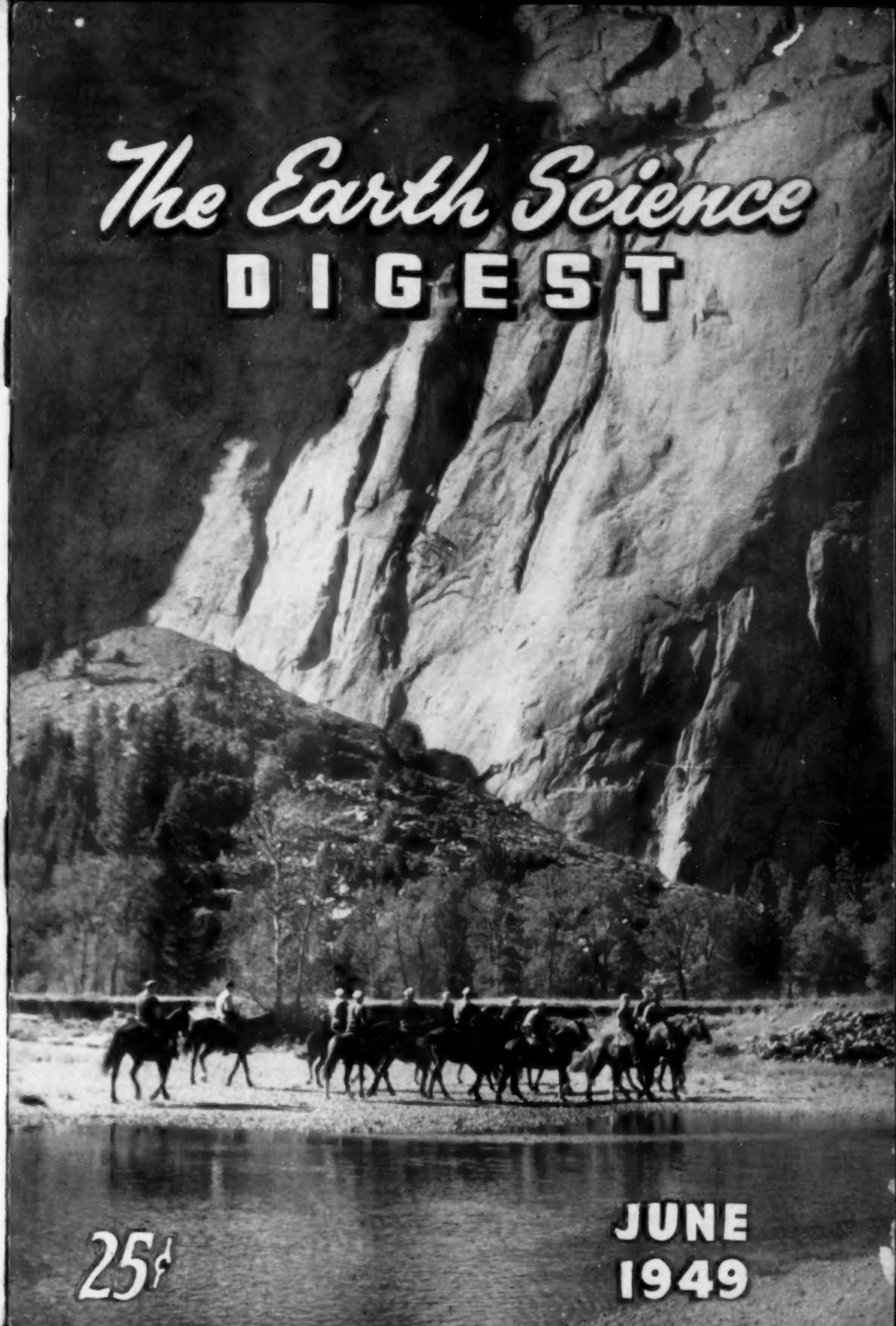
The Earth Science
DIGEST
25¢
JUNE
1949

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The Earth Science Digest

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A magazine devoted to the geological sciences.

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CONTENTS

Delo Appointed Executive Director of American Geological Institute

The appointment of Dr. David M. Delo of Washington, D. C. as the first Executive Director of the American Geological Institute, was announced recently by Dr. Detlev W. Bronk, Chairman of the National Research Council.

The American Geological Institute is a new organization established in November 1948 which will represent the profession of geology. It is composed of a union of eleven geological societies whose members total more than 10,000 professional geologists. Headquarters will be located in the National

Research Council, 2101 Constitution Ave., Washington 25, D. C. and the activities of the Institute will be carried on in conjunction with those of the Division of Geology and Geography, NRC.

The primary objectives of the new Institute are the advancement of geology and its application to human welfare by providing a means for the cooperation of organizations active in the fields of pure and applied geology. Membership is open to all non-profit organizations concerned with the earth sciences — geology, geophysics, geochemistry, mineralogy, etc. The initial member organizations are:

American Association of Petroleum Geologists.

American Geophysical Union.

American Institute of Mining and Metallurgical Engineers.

Geological Society of America.

Paleontological Society.

Seismological Society of America.

Society of Economic Geologists.

Society of Economic Paleontologists and Mineralogists.

Society of Exploration Geophysicists.

Society of Vertebrate Paleontology.

The Institute is organized as an instrument of the National Research Council, in this way uniting geologists with all other American scientists who are seeking solutions to problems which can be attacked best through group or united action. Initially its functions will be concerned primarily with the nonresearch activities of the geological profession, and will supplement the work of the Division of Geology and Geography of the National Research Council which is chiefly concerned with the coordination of research in geology and geography and its interrelationships with allied sciences.

Officers of the Institute are A. I. Levorsen, Dean of Mineral Sciences, Stanford University, president; W. B. Heroy, Beers and Heroy, Dallas, Texas, vice-president; and Earl Ingerson, U. S. Geological Survey, Washington, D. C., secretary-treasurer.

Dr. Delo began his duties on June 1. He has served for the past three years as Chief of Scientific Manpower for the Research and Development Group, Logistics Division, General Staff, U. S. Army. During the World War II he was a Technical Aide in the Office of Scientific Research and Development and prior to that time was Chairman of the Department of Geology and Geography, Knox College.

The new Executive Director is a graduate of Miami University (Ohio) and received his doctorate degree from Harvard University.

Cover Photo

Convalescent patients from the U. S. Naval Special Hospital on an afternoon horseback trip around Yosemite Valley, are shown in this National Park Service photo by Ralph H. Anderson. Yosemite Valley, part of Yosemite National Park, California, is a magnificent gorge, world-renowed for Half Dome, El Capitan, and other lofty peaks, and for Yosemite Falls, with a total drop of almost half a mile. The Valley is about 7 miles long, with a 4000 feet elevation, and averages one mile in width and half a mile in depth. It was cut by the combined action of the Merced River and glaciers. The preglacial Merced River was repeatedly accelerated in speed by uplifts of the earth's surface. With each increase in velocity, the river cut its channel deeper, finally fashioning a narrow V-shaped canyon. Powerful glaciers widened this canyon during the ice age to a broad U-shaped trough. A lake 5½ miles long was created by the melting glaciers. Quantities of sand and gravel were deposited into this lake by the Merced River, eventually filling the lake and producing the level floor.

THE SEARCH FOR URANIUM

W. S. SAVAGE
Ontario Department of Mines

*Part One of a Three-part Article**

Introduction

Uranium was discovered by Martin Klaproth in 1789, and the element was isolated in its metallic form for the first time by Eugene Peligot in 1847. The hitherto unsuspected property characteristic of all uranium-bearing minerals and now known as "radioactivity" was discovered accidently by Prof. Becquerel in Paris in 1896.

Becquerel, who was experimenting with fluorescent minerals, happened to place a piece of uranium-bearing mineral on a wrapped photographic plate in one of the drawers of his desk. Some time later he used the photographic plate and on developing it was astonished to find an image of the mineral specimen. Only an invisible penetrating radiation could explain this phenomenon, and Prof. Becquerel gave the problem of its investigation to one of his pupils, Marie Curie. Madame Curie and her husband Pierre found one other element, in addition to uranium, that was radioactive. This element was thorium, and the Curies were soon able to show that the capacity to fog a photographic plate in the dark was proportional to the uranium or thorium content of the mineral, depending on which it contained.

There was one exception. This was the black mineral pitchblende, which, though it contained uranium, showed a radioactivity much more powerful than could be accounted for by its uranium content, The Curies suspected another much more powerful radioactive element closely associated with uranium, occurring as a very trifling percentage of the whole in the mineral pitchblende. After several years of painstaking work, the Curies succeeded in isolating a very minute quantity of this element, to which they gave the name "radium." The proportion of radium to uranium in pitchblende is one-third of one part per million.

The therapeutic value of radium was soon recognized by the medical profession, and for many years uranium-bearing minerals were mined for their radium content. The extensive carnotite deposits in Colorado and Utah were exploited for a number of years, yielding uranium (for the radium content) and vanadium. The very rich deposits of pitchblende in the Belgian Congo were first discovered in 1913 and proved to be so rich that it was no longer possible for the carnotite deposits in the United States to compete on a commercial basis. The pitchblende deposits of Great Bear lake in Canada were discovered in 1930, and these in turn proved more economical to mine than those of the Belgian Congo. In the process of extracting radium from these uranium ores, the tailings that contained uranium were often sold as by-products, if they could be sold at all, or were dumped outside the refineries.

* Published by permission of the Deputy Minister, Ontario Department of Mines.

Most persons by this time know that the element uranium has played the chief role in the development of the atomic bomb, and the public has been made amply aware, through the press and radio, of the enormous significance that the discovery of means for releasing nuclear or atomic energy must inevitably have in the general world economy. It follows, therefore, that the provision of greatly increased supplies of uranium has become a matter of paramount importance. Every nation on earth, large and small alike, is now engaged in a feverish search for uranium resources. Politically, the nation that has large reserves of uranium ore assumes a stature far out of proportion to mere size, or population, or wealth.

The element uranium, being a metal, occurs in minerals and ores in the same way as copper, iron, lead, zinc, or any of the other metals commonly used in industry, and the same fundamental principles that have been successfully applied in prospecting for these other metals are equally applicable to the search for uranium ores. It is therefore natural that the broad facts relating to the character, mode of occurrence, and means of distinguishing uranium minerals should be of special interest.

Uranium and Thorium Minerals

It is not generally realized that uranium is not a rare element, being more abundant in the earth's crust than silver, antimony, and mercury combined. The content of uranium in the earth's crust is 4 parts per million and of thorium is 11.5 parts per million. It must be pointed out, however, that relative abundance is not necessarily indicative of availability. Unlike many elements uranium is not widely found in rich bodies, and it may be intimately associated with other chemical relatives in igneous rocks.

All rocks contain perceptible amounts of radioactive elements, i.e. measurable quantities of uranium and thorium minerals. The more acidic, light-colored igneous rocks, such as the granites and rhyolites, contain from 10 to 20 grams of radioactive elements per ton, of which about 25 per cent is uranium and the remainder thorium. The more basic and darker igneous rocks, such as basalt, have only from 3 to 8 grams of radioactive elements per ton.

Uranium-bearing minerals are distributed throughout the world with practically every country having one or more known occurrences. In most cases these deposits are only of minor importance compared with those that have been mined on a commercial basis for radium and uranium. It was estimated in 1941 that about 75 per cent of the known reserve of uranium was in the hands of the United Nations. These reserves include the well-known deposits of Canada, the Belgian Congo, and the United States.

There are many low-grade deposits of uranium minerals that have received little attention. Under conditions of mining uranium ores solely for the radium content, low-grade deposits obviously could not enter into the picture. With the development of the atomic bomb and the possibility of using nuclear energy for power purposes, it is very likely that all low-grade deposits of an extensive nature will be carefully investigated and subsequently utilized.

The number of known minerals that contain uranium in some measure is quite large, but most of these are rare and the content of the element is so low and so variable that these minerals are of little practical importance as a source of uranium. The bulk of the world supply of uranium up to the present has been obtained from deposits of the following minerals:

Primary mineral,

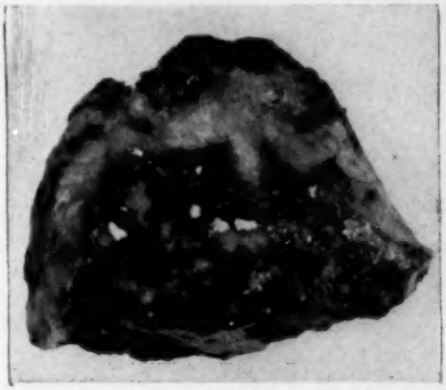
Pitchblende (massive variety of uraninite).

Secondary minerals,

Carnotite - Tyuyamunite
Autunite - Torbernite.

Pitchblende, which is a natural uranium oxide, is the richest and commercially the most important ore of uranium. It is the only primary uranium mineral that occurs in the form of definite veins or lodes. It may be the dominant mineral or it may occur as an accessory in veins of other metallic ores, notably those of silver, cobalt, and nickel. Pitchblende is generally deposited from hydrothermal solutions in the form of veins or stringer systems occupying faults, shear zones, or fractures, but some disseminated pitchblende may occur in the wall rocks. In this form concentrations of pitchblende are comparable in many respects to common types of gold and base-metal deposits, and the same considerations of geological structure that guide prospecting for these deposits will aid materially in the search for pitchblende.

In his paper on "Prospecting for Uranium in Canada," Dr. A. H. Lang, of the Geological Survey of Canada, stresses the fact that as the minerals with which pitchblende is associated in Canadian hydrothermal deposits vary greatly in kind from one property to another, no definite rules for mineral associations can be made. At several properties, pitchblende is associated with some of the following minerals: native silver, complex cobalt or cobalt-nickel minerals, chalcopyrite, pyrite, hematite,



Ellsworthite from Hybla, Ontario. This chocolate-brown mineral, containing up to eighteen per cent uranium oxide, is a variety of pyrochlore, a complex oxide containing essentially calcium, sodium, columbium, and tantalum, with hydroxyl and fluorine. The light colored crystals are microcline.

quartz, and various carbonate minerals. The extent to which these associations are accidental and the extent to which they are reliable guides to prospecting are not well known at present.

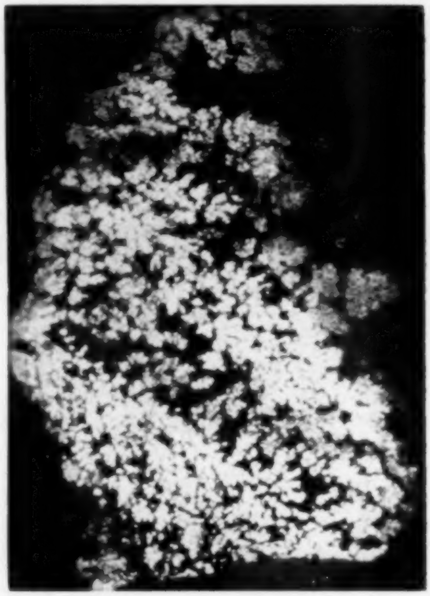
Pitchblende is characterized by black color, metallic appearance, greasy or pitchy lustre, dense massive texture, and exceptional weight. It sometimes occurs in botryoidal or kidney-like masses or crusts, which under a lens are seen to have a radiated texture. In this last form, pitchblende somewhat resembles hematite, with which it is often closely associated, but it may readily be distinguished from hematite by the black or greenish-black color of its streak or powder, in contrast to the strong red color for hematite.

Pitchblende deposits have been found in so many different types of rocks that no general rules for favorable host rocks can be given. The problem is peculiar to individual districts, and even in these, geological structure is commonly more important than rock types.

Almost all the other primary minerals are confined in their occurrence to granitic rocks, more especially to pegmatite, which is a dike-forming type of granite in which the chief component minerals occur in large crystals or masses. The variety of uranium minerals found in such association is large, and for the most part these minerals are of complex composition. They are mostly black or dark brownish-red in color, conspicuously heavy, and often of a submetallic appearance, and they sometimes occur in well-developed crystals. As a rule, such minerals occur rather sparsely disseminated in the host rock, though occasionally they form small nests or pockets, or are concentrated in zones containing large aggregates of black mica. None of these has yet been proved to be a commercial source of uranium. The occurrence, also, of a black, coal-like hydrocarbon mineral (thucholite or anthraxolite) which will burn, in a pegmatite is suggestive of the presence of uranium, and this material itself often contains a considerable amount of the element.

Primary uranium minerals are rather prone to alteration and breakdown under weathering agencies, and for this reason they are seldom likely to be found with the fresh outward characteristics preserved in surface outcrops. Uraninite, as well as its massive variety pitchblende, may weather to a greenish cast, but both are more likely to exhibit characteristic and vividly colored yellow and orange secondary products.

Secondary uranium minerals are those formed by the alteration of primary species by weathering or other natural agencies. They may be found replacing the original minerals *in situ*, but more commonly have been precipitated out of solutions derived from such minerals. The dissolved uranium salts may have been carried considerable distances by circulating or surface



Harvard University

An autoradiograph of dendritic uraninite from the Ruggles Mine, near Grafton Center, New Hampshire.

waters with the formation of rich concentrations in certain favorable areas, such as the deposits of "carnotite" in Colorado and Utah.

Deposition from solution may have also occurred adjacent to the primary source, on cracks and joints in the enclosing rock. The "torbernite-autunite" deposits of South Australia and Portugal are examples of this type of deposition. These two species, the so-called "uranium micas," are the only secondary uranium minerals that commonly occur in crystal form. They occur in small, brittle, cleavable plates, which for torbernite are of an emerald-green color and for autunite are bright lemon-yellow.

Carnotite (potassium uranyl vanadate) is by far the most important uranium-bearing mineral found in the United States. It most frequently occurs as a yellow crystalline or amorphous powder in loosely cohering masses. In the

Colorado and Utah deposits the carnotite occurs chiefly in sandstone, concentrated along cracks or bedding-planes or in pockets, and less commonly as an impregnation. Tyuyamunite is a variety of carnotite found in Russia in which calcium takes the place of potassium.

There are a large number of other species of secondary minerals in which the salts of uranium and various other metals are combined. These minerals for the most part occur as either powdery coatings or soft massive material. Intense and vivid colors, in shades of bright yellow, orange, and green, are the chief distinguishing features of such minerals and serve at once to attract attention to them.

A tropical climate is necessary for the formation of important deposits of secondary uranium minerals. Such minerals, are very important in that they may serve, even in small traces, as indicators of the possible nearby presence of primary ore.

Thorium is an element that has somewhat similar properties to uranium, and it is not uncommon for certain primary uranium minerals, more especially those found in pegmatites, to contain moderate amounts of thorium, but on the whole, straight thorium minerals that might be regarded as commercial sources of the element are much less common than uranium minerals, although thorium in the earth's crust is almost three times as abundant as uranium.

Up to the present practically the entire world supply of thorium has been obtained from the single mineral "monazite," which contains up to 18 per cent thorium. It is a non-metallic mineral, yellow to reddish brown in color, conspicously heavy, and of crystalline character. It occurs as tabular crystals in pegmatic dikes and as small grains in rocks intruded by granite and pegmatite, but most of the commercial supply is obtained from rich concentrations formed by wave action in beach sands along the coasts of India, Brazil, and Australia. It is doubtful if occurrences of monazite in rock would be currently of economic interest. Any concentration of thorium-bearing minerals, however, should be recorded, since it is quite possible that a means may be found for utilizing thorium as a source of atomic power.

The richest thorium mineral known is "thorianite" (38-93 per cent thorium), a heavy, black metallic mineral, which occurs in small cubic crystals in pegmatites. It is known in commercial amounts only in alluvial placer deposits and is an exceedingly rare mineral, whose principal source is Ceylon.

Allanite is a complex mineral which may carry up to 3 per cent thorium. It is a heavy, non-metallic mineral, black when fresh, but usually severely altered externally to a brown color. Small crystals are in places abundant in granitic rocks, and in pegmatites the mineral may occur in large crystals 20 pounds or more in weight. While allanite has not so far come into consideration as a commercial source of thorium, it might serve as such if found in sufficiently rich deposits.

Thorium is not precipitated out of solution in circulating waters, as is uranium, and hence important deposits of secondary minerals are unknown or are of relatively small importance. A number of complex primary minerals occur which contain thorium, but as a rule these species are of rare occurrence and for the present of only mineralogical interest.

NEXT MONTH: Part Two — Prospecting for Radioactive Minerals, and the Geiger Counter.

OIL FROM COAL — A NEW INDUSTRY

Excerpts from the dedication booklet prepared by the Office of Synthetic Liquid Fuels of the Bureau of Mines for the dedication of the coal to oil demonstration plants at Louisiana, Missouri, May 8, 1949.

Today this Nation is witnessing the birth struggle of a new industry, an industry of incalculable significance to our future economic welfare and military security—an industry based on the conversion of coal to oil and gasoline.

In the Coal-To-Oil Demonstration Plants here at Louisiana, Mo., and in laboratories and pilot plants elsewhere, scientists and engineers of the Bureau of the Mines are at work under the authorization of the Synthetic Liquid Fuels Acts, preparing a formula of technical and economic knowledge to nourish this potential industrial giant.

The trend is clear. The United States has been largely independent of outside petroleum sources since its first well was sunk and an oil industry founded, nearly a century ago. Until fairly recently, our domestic reserves generally had been considered adequate for the expanding requirements of America's industrial economy and for any conceivable military demand. They no longer are so regarded.

Ill-Prepared for Emergency

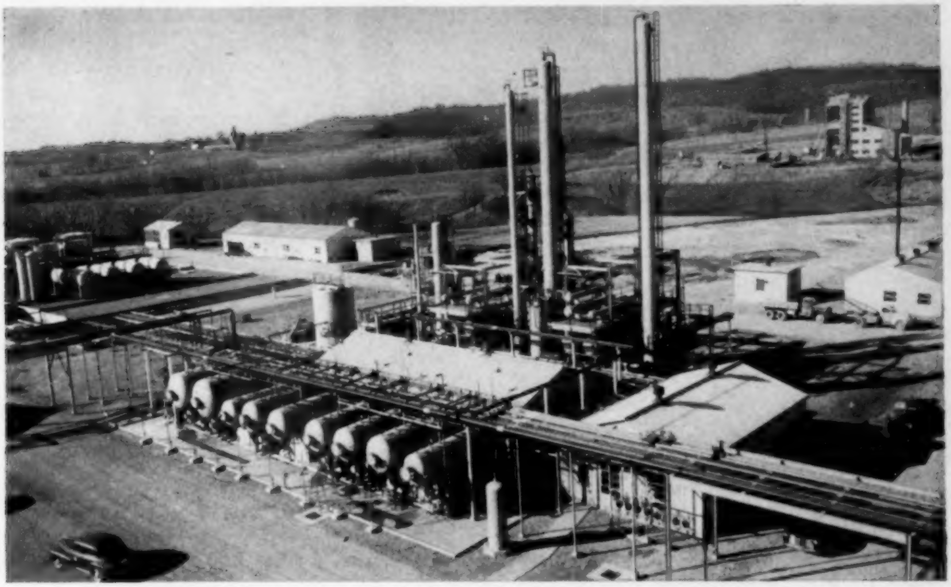
Our present consumption of petroleum products is far greater than during the height of World War II, and requirements anticipated for any future war must be estimated at a rate half again that of the past conflict. If there is another war, the liquid-fuel problem will be immediate and acute. If peace continues, as we fervently hope, we still cannot continue for long to meet the enormous demand from our petroleum reserves or even from those in the Western Hemisphere. When compared with today's ruthless withdrawal, the estimates of both proved and undiscovered reserves show unmistakably that we must look elsewhere for our long-term requirements.

We cannot afford to view complacently the current availability of oil for our furnaces and gasoline for our cars. In stepping up the drain on our oil field in recent years, we now know that we are hastening the day of virtual depletion. As with other minerals, our petroleum is irreplaceable. We cannot grow and harvest a new crop at will.

Synthetics Offer Self-Sufficiency

A synthetic liquid fuel industry based on coal and oil shale offers an assured supply, adequate for hundreds of years, from known reserves within the borders of the United States—in short, self-sufficiency for whatever the future holds in these times of international turmoil and uncertainty.

Singularly blessed with coal, the base of our industrial pyramid, the United States is estimated by geologists to contain reserves of more than 3 trillion tons—one-half of the world's known deposits. This is enough to support our existing vast structure of basic industries



U. S. Bureau of Mines

Distillation area of the Bureau of Mines Coal Hydrogenation Plant at Louisiana, Mo. Here the oil products obtained from coal are separated and refined to high-quality liquid fuels.

for centuries and, in addition, to supply all of our liquid-fuel requirements. Even if we assume that only half of this coal is recoverable, it still amounts to 95.6 percent of our entire fuel resources. By comparison, on the same basis of heating value, our recoverable shale oil totals 3.6 percent, our proved natural gas 0.4 percent, and our proved petroleum 0.4 percent. Although our oil-shale beds have not been thoroughly explored and we cannot forecast the size of future oil and natural-gas discoveries with accuracy, it appears certain that the ultimate reserves of all these will be small indeed compared to those of coal.

Long concerned about the gradual exhaustion of petroleum reserves and the need for developing supplementary sources of gasoline and oil, the Bureau of Mines pioneered this country's research on the production of synthetic liquid fuels—starting preliminary investigations on oil-shale treatments in 1916 and on synthetic oil from coal in 1926.

All of the Government's synthetic-fuels research laboratories and demonstration plants save one—the Gas-Synthesis Demonstration Plant adjacent to the Coal-Hydrogenation Demonstration Plant here at Louisiana, Mo., now are completed and in, or ready for, full operation. This final demonstration plant should be completed this year.

Coal-to-Oil Demonstration Plants

The two Coal-to-Oil Demonstration Plants here at Louisiana, Mo.—less than 100 miles above St. Louis on the Mississippi River—are the first such units larger than pilot plants in the United States and the most advanced of their type anywhere.

This site, centrally located with respect to the Nation's major coal fields, was chosen after a Nation-wide survey in which 206 proposed locations in 21 coal-producing States were considered carefully.

The $17,500,000 Missouri Ordnance Works, built originally for the Army Ordnance Department, was transferred to the Bureau of Mines by the Office of the Quartermaster General in the spring of 1947. An earlier transfer had been rescinded when the plant was recalled into temporary emergency service to help relieve a postwar shortage of ammonia for fertilizer.

Acquisition of this ordnance plant saved the Bureau several million dollars in construction costs and considerable time. It was not a development lacking in precedent, however, for synthetic-fuel plants in England—and formerly in Germany—frequently were operated in connection with synthetic-ammonia plants to obtain the most efficient use of raw materials, plant facilities, and personnel.

The respective merits of two basic processes of German origin for converting coal to oil will be demonstrated here in the new synthetic fuel plants, which include scientific and engineering improvement and modifications. These processes are: (1) The direct hydrogenation of coal, or Bergius-I. G. Farben process; and (2) the gas-synthesis or Fischer-Tropsch process of first gasifying the coal and then converting the resulting synthesis gas to liquid fuels. These processes are complementary rather than competitive. Although the Bureau employs coal as the raw material in both, the liquid products that each process is best adapted to produce differ and range from heavy fuel oils to aviation gasoline.

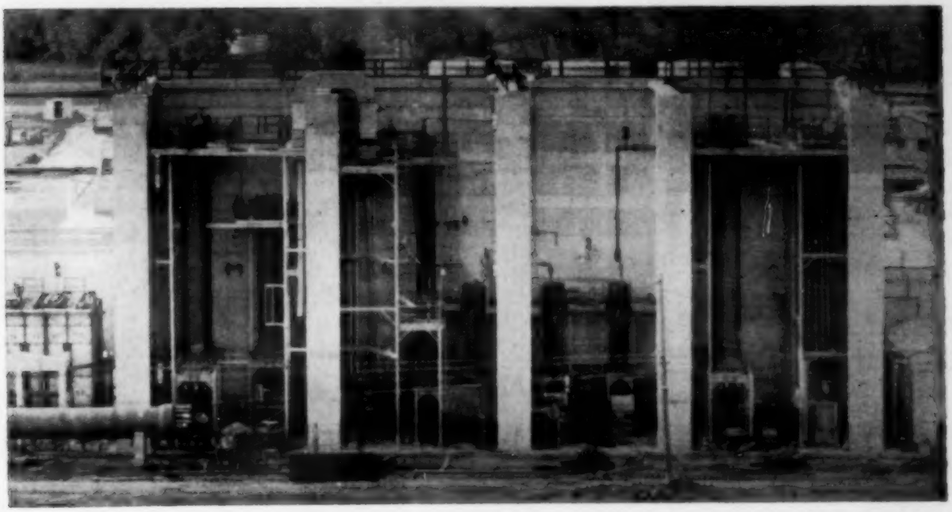
Coal-Hydrogenation Plant

The Hydrogenation Demonstration Plant, the first of the new plants at Louisiana, now is ready to produce oil and gasoline from coal.

Chemically, crude petroleum contains more than twice as much hydrogen as does coal. Thus, to convert coal to finished gasoline by the hydrogenation process, which was patented at the beginning of World War I by a German chemist named F. Bergius, hydrogen is combined with the coal under high pressure and temperature, with the aid of a catalyst to promote reaction.

In the Bureau's demonstration plant, "raw coal" first is crushed, dried, and pulverized in the coal-preparation area and then transferred to a 60-ton bin in the pasting area. There, after addition of a small quantity of catalytic material, such as iron oxide or a compound of tin, about equal parts of finely pulverized coal and heavy oil obtained from the process are mixed to form a paste. The heavy, viscous paste is put under pressure and injected by steam-driven, plunger-type pumps into a gas-fired tubular preheater, where it becomes as fluid as water when it approaches reaction temperature.

At last the paste reaches the heart of the plant—giant liquid-phase converters enclosed in protective, reinforced-concrete stalls. In these massive forged cylinders of low-chrome steel—each weighing approximately 100 tons—hydrogen is reacted with the coal to form oil and some gasoline. The converters are 32 inches in diameter and 39 feet in height by inside measurement; each contains a reaction "basket" 24 inches in diameter. The annular space between the converter shell and basket is filled with insulation to keep the shell cool and maintain



U. S. Bureau of Mines

Open side of converter stalls, Bureau of Mines Coal Hydrogenation Demonstration Plant, Louisiana, Mo. This large reinforced concrete structure is partitioned in stalls which enclose on three sides the high-pressure and -temperature vessels in which coal is converted to oil.

the full tensile strength of the metal. As the reaction is highly exothermic or heat-producing, cooling hydrogen must be injected at several points to hold the temperature at 900° F.

Coal Becomes Oil in an Hour

After about 1 hour in the reaction zone, 95 percent of the coal is converted to gaseous and liquid products suitable for use or for subsequent processing. Leaving the second converter, the reacted product passes through the hot and cold catchpots to separate the heavy oil, light oil, and gases.

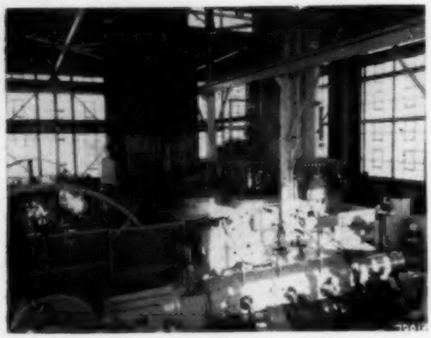
After the pressure is reduced, heavy oil is freed from ash, catalyst, and unreacted coal by centrifuging or by flash distillation and is returned to the paste-preparation area to be mixed with incoming coal. The lighter products are depressured, distilled, and passed on to the vapor-phase section of the plant for further hydrogenation.

Again under pressure of 10,300 pounds per square inch, these products are injected, with hydrogen, into a heat exchanger and a preheater before being passed as vapor over a catalyst supported on metal trays in another converter. With each pass through this converter, about 50 percent of the charge stock is changed into gasoline. After the pressure is relieved, this product is sent to the distillation area, where it is separated by fractionation and made into a high-quality fuel.

Gas-Synthesis Plant

Now under construction, the second of the new units—the Gas-Synthesis Demonstration Plant—is scheduled for completion this year.

This plant, an 80- to 100-barrel-per-day unit, will gasify pulverized coal with oxygen and superheated steam and then convert the resulting synthesis gas—a mixture of carbon monoxide and hydrogen—to liquid fuels by the Fischer-Tropsch process. First announced in Germany by Franz Fischer and Hans Tropsch in 1926, this process, with American modifications, is well-adapted to the production of



U. S. Bureau of Mines

Oxygen is extracted from the air at temperatures more than 300 degrees below zero in this equipment at the Coal and Oil Demonstration Plants of the Bureau of Mines at Louisiana, Mo. Operators are at the controls of the oxygen rectification column; compressor is seen in foreground.

either a good-grade motor gasoline or an excellent Diesel fuel.

Incorporating advances made in the Bureau's broad program of research on this process, the Gas-Synthesis Demonstration Plant will consist of four distinct parts: (1) Coal gasification; (2) gas purification; (3) hydrocarbon synthesis; and (4) refining of products.

Coal Gasification No. 1 Problem

Coal gasification is not only the first step in both basic processes for the production of synthetic liquid fuels but the ranking cost problem now requiring solution in obtaining competitive gasoline and oil from coal. In the Fischer-Tropsch process, the synthesis gas obtained thereby constitutes roughly 60 percent of the cost of the liquid-fuel products. In the coal-hydrogenation process, the hydrogen now represents 40 percent of the cost of the products.

For this reason, the Bureau of Mines is concentrating the efforts of a substantial part of the synthetic-fuels and coal-research staffs on various phases of this problem. Four different methods are under intensive study, and encouraging progress is being made.

The Bureau's Gas-Synthesis Demonstration Plant employs a continuous gasifier, developed by the Koppers Co. that does not require the use of coking coals. Priority has been given this part of the construction, and runs will be made while the synthesis section is being completed. Space is available for the construction later of any unit that appears promising on the basis of laboratory and pilot-plant tests.

Briefly, the plant's coal-gasification cycle involves first crushing, pulverizing, and drying the coal. Then, suspended in oxygen and accompanied by superheated steam, the coal is fed into the gasifier—a refractory-lined steel shell 6½ by 9 feet in internal measurement. There the conversion takes place at more than 2,000° F. The gasifier, fed from both ends, requires about 28 tons of coal, 24 tons of oxygen, and 35 tons of superheated steam daily to produce some 2 million cubic feet of raw synthesis gas. So far as is known, this is the largest unit ever installed for direct production of synthesis gas from finely powdered coal and oxygen.

Steam required for gasifying the coal is superheated in a natural-gas-fired pebble heater. The oxygen is extracted from the air at temperatures more than 300° F. below zero in a Linde-Fränkl unit originally used in making chemicals at Hochst, Germany. This tonnage oxygen producer was brought to the United States and completely reconditioned before being put in service; it has a capacity of 23,000 cubic feet or 1 ton per hour of 98 percent oxygen.

The long-term trend in the liquid-fuel-energy demand curve is inexorably upward, reflecting a growing population, increasing industrial activity, and a rising national income—all constituents of American progress and a standard of living that less fortunate nations covet.

ALEUTIAN VOLCANO ERUPTS

After a relatively quiet period of a little over two years, Akutan volcano, a 4,200-foot cone in the Aleutian Islands, 27 miles northeast of Dutch Harbor, has erupted again, according to a report received by Director W. E. Wrather, of the U. S. Geological Survey.

According to Hugh McGlashan, postmaster at Akutan, a village 8 miles east of the volcano, 1/8 inch of ash fell on the village during the night of April 29. Ash mixed with sleet continued to fall all during the following day because of a steady west wind from the direction of the volcano. Now snow on the higher slopes of the volcano is covered by a heavy black layer of ash. The eruption continued full scale until May 10 and then decreased somewhat in intensity.

On May 17 several of the villagers made a closer approach to the volcano and reported hot lava flowing down the northwest slope. Considerable steam was rising at the front of the lava where it encountered the winter blanket of snow. This material may have been a hot mudflow, formed by lava mixing with snow, ice, and boulders inside the crater.

The crater of the volcano is about a mile wide and 500 feet deep, except where breached by a gorge on the northwest side. The vent from which ash and lava are erupted is marked by a cinder cone in the northeast part of the large crater.

Prior to the present eruption Akutan volcano erupted during January 1947, and a thick flood of lava covering an area one half mile square was poured out into the crater. Very little ash fell on Akutan village then, because fortunately the wind remained in the right direction to blow the erupting ash out to sea. At the onset of the 1947 eruption, the commandant of the Seventeenth Naval District at Kodiak ordered a Navy auxiliary tug to evacuate the villagers if necessary.

During August 1948 the crater area of Akutan volcano was examined by geologists of the U. S. Geological Survey, who mapped the limits of the 1947 lava flow and of earlier lava flows. During the geologists' visit large boulders and ash were noisily ejected from the cinder cone inside the crater at irregular intervals ranging from a few minutes to several hours. The boulders fell over a limited area around the base of the cone, but some of the lighter ash fell on the geologists' tent pitched 3 miles from the volcano.

Akutan village is the only settlement in the area and has about 60 inhabitants. Two ridges intervene between Akutan village and the volcano so that the village is not threatened by lava flowing from Akutan volcano. The gravest threat to the village is from a heavy ash fall, which would force evacuation, similar to that at Kodiak during the great Katmai eruption of 1912.

Approximately two weeks prior to the recent eruption, three heavy earthquakes were felt at the village. Heavy shocks over a restricted area near a volcano are generally premonitory rumbling of an impending volcano eruption. The only proven means of predicting volcanic eruptions is by study and interpretation of earthquake shocks, usually recorded by seismographs.

Letters To The Editor

Dear Mr. Eisenberg,

. . . The article "The Moonscar Upon the Earth" is indeed one to stimulate interest, amongst laymen and scientists alike.* Essentially I do not find that Kuehn has much new to say, and what is of a newer type seems indeed most speculative. It is perhaps a pity that he does not give a list of references in order that one might check his statements more carefully.

Interesting though the article is, yet this article, and any other I have read re. the business of the moon-earth relationship (vide Escher's recent article in the Bull. Geol. Soc. Amer.) fails to answer what to me at least are most pertinent questions. I list these very briefly below:

1. The continents occupy but a fraction of the total earth surface, yet granites (acid magmas-sial) seem to have concentrated within such small areas. How to explain this?

2. Mohorovicic's estimate of the thickness of the moon's sial is some 400 kms; that of the earth, 60 kms. His error lies in assuming an original crust of continental thickness, and he fails to take recognition of the 'floats' of sial represented by the Atlantic and Indian oceans.

3. The moon's sial was originally part of the earth—according to Kuehn and others. A sialic 'gap' must therefore have been created on the earth. Either one of two things must have happened: either the remaining sial flowed laterally and closed this 'gap' to form a continuous shell again, or the 'gap' was left open. According to which particular theory a person is trying to develop, he will assume one case or the other, but in the final analysis, his choice is purely arbitrary. From this, to go on and build his framework represents weak arguing.

*The Earth Science Digest, Vol. 3, Nos. 7 and 8, February and March 1949.

4. The moon is assumed to have a continuous sialic shell, whilst the concensus of geological opinion is to the effect that this is discontinuous on the earth —the continents, Atlantic and Indian oceans only. If the moon's sial is essentially the same as that of the earth, why was it able to form a continuous shell on the moon and not on the earth; or then the converse, why is it 'patchy' on the earth and continuous on the moon?

5. The moon's sima is also supposed to have been derived from the earth, according to the postulate of Kuehn—which is, of course, merely that of the resonance theory of Sir George Darwin. Presumably at the time the moon was torn from the earth, there was also a sima 'gap' which evidently was filled, as by all theories, the shell of the sima on the earth is continuous. Why did the sima manage to flow back and close the 'gap' and not the sial?

As Kuehn has made mention of petrology and matters of rock densities, etc., it is a pity he does not refer specifically to the work of Lawson and Rittmann and their views regarding original basaltic—i.e. simatic, continents.

I could go on at length and discuss in far greater detail several points brought up by Kuehn. However, your journal is not aimed at presenting erudite, highly technical articles, nor the published discussions thereof. I would mention that if you are prepared to accept for publication such highly controversial articles as that of Kuehn, perhaps you should be prepared to receive quite technical discussions thereof.

Thanking you again for your kindness, and wishing all success to your journal.

Yours truly,

RAOUL C. MITCHELL

Associate Professor of Geology
School of Mineral Industries
The Pennsylvania State College
State College, Pennsylvania

PETROLIFEROUS GEODES

THEIR OCCURRENCE AND ORIGIN

ROGER L. SPITZNAS
University of Missouri

As a portion of the Keokuk, Iowa, geode region, the Tyson Creek locality in western Illinois is distinct in that it has produced numerous geodes of varying sizes which contain a thick, black petroliferous mixture.

It is now a common practice for geology classes to come to the locality to seek petroliferous specimens. The locality is easily accessible on Illinois State Highway 96 where it crosses Tyson Creek about two miles south of Niota, Illinois. Within a few feet of the highway are exposures of the Warsaw formation (Mississippian) which carries the geodes. Other exposures a little more remote from the highway present better collecting grounds where geodes are exposed along the stream in cliffs of Warsaw shale twenty feet high.

Many minerals have been reported from geodes other than the most common quartz and calcite mineral fillings, and a list of some of these less common geodic minerals include sphalerite, kaolinite, and millerite. Such occurrences of these and other minerals have made the study of, and search for, geodes a far more interesting pursuit than does the common mineral filling. Of greater interest to the writer has been the presence of petroliferous mixtures within the siliceous geodes collected at the Tyson Creek locality. The petroleum mixture is heavy and black, and it becomes highly viscous upon the

Roger L. Spitznas

View of part of the Tyson Creek outcrop of the Warsaw shale (Mississippian) from which the petroliferous geodes were collected.

evaporation of volatile compounds at normal temperatures.

Though the locality is beyond the northern limit of probable oil production for the state, there are oil seeps occurring in the stream bed below the outcrop pictured in Figure 1. The outcrop has evidences of oil staining in many small horizons throughout the cliff, and some of these oil stained bands coincide with the horizons from which petroliferous geodes are collected. However, even though geodes occur within one such band or streak, their presence within the band does not assure that every geode from the horizon will be found to contain the petroliferous mixture. The presence of oil within the geode seems to have no direct relationship to the size of the geode for any size specimen

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A petroliferous geode, about 3½ inches in diameter, from Tyson Creek, showing the oil flowing from the opening.

may, if its position and physical features are right, contain oil. Also, there seems to be no correlation between the thickness of the shell of the geode and the presence of oil within, as thick and thin-walled examples of oil bearing geodes are found intermingled. Thus, it seems certain that the size and wall thickness of the geode have no relation to the presence of oil within the specimen except in cases of complete mineral filling where all possibility of oil is eliminated.

The question of the formation of geodes is itself interesting when one considers the possible ways in which the original open spaces may have been created within the solid rocks. Ideas on this point range from gas bubbles included within the material at the time of its deposition to solution work after consolidation. Whatever may be the correct answer to the origin of the holes, it must in some measure account for the highly spherical nature of the cavities which are later lined and filled with mineral matter brought into the cavity by ground water. Some of the geodes have flattened bottoms which might be accounted for in part by the bedding plains within the enclosing rock. It has been commonly seen that the bedding plains do form, or coincide with, the flattened bottoms of some geodes. Another feature, a crushing of geodes does occasionally occur, and it is supposed that partial or complete collapse occurred after the deposition of a thin cavity lining from mineral matter carried by ground water. This may or may not be fact.

The question of the means by which the oil came to be enclosed within these geodes is still an open one. Several thoughts on the matter have been expressed from time to time. One idea is the enclosure (syngenetic) of organic material within the original cavity, and this organic matter produced the petroleum that is now found in the cavities of geodes. This hypothesis seems inconsistant with conditions of oil seepage seen in the Tyson Creek area. Still another idea is the carrying of liquid petroleum into the cavity in the same manner that mineral-ladened waters enter. The latter hypothesis and the possibility of gaseous introduction seem more consistant with the evidence presented in the Tyson Creek exposures.

The presence of oil seeps in the locality at the present time indicates that the introduction of the oil into the geodes was a recent event. Also supporting recent introduction of petroleum is the relationship of oil content within the varying sizes of geodes. It is much more common to find small geodes whose cavities are completely filled by petroleum than to find large geodes which are completely petroleum filled. In the case of the larger specimens, it is more common to find them occupied by neither oil nor other mineral matter. This might be construed to mean a period of oil introduction whose duration has been sufficient to fill small cavities while the larger geodes having cavities of greater volume are, as yet, only partially filled.

It is doubted if the introduction of the oil occurred with the strata at their present topographic position. By this it is inferred that either the area has experienced uplift; or erosion has lowered the stream level of the region, and thereby, the water table level. Either event would provide the lowering of the water table which, as explained later, is seemingly necessary for introduction of the oil. This change of topographic position is even more a certainty if the petroleum was introduced into the geodes in the liquid state. If the oil was in the liquid state when introduced, conditions of complete burial seem necessary; or the oil which is under pressure, as shown by present day seepage, might tend to seek the exposed cliff front rather than enter into the geodes where some resistance to entry might be encountered. Because of the greater capacity of water to occupy pore spaces, even to the exclusion of oil, the resistance to entry by the oil would be greatly increased or made insurmountable if water occupied the cavity and the pore spaces of the mineralized exterior of the geodes. Since the two liquids, oil and water, are nonmixing liquids, any possibility of osmotic entry of the oil is precluded.

It would seem, therefore, that the oil found its way into the geode cavities at times when they and the pore spaces of the exterior wall were not occupied by water. These periods of absence of water from the geode may be brought about by a shifting in the vertical position of the water table, and such a variation of the water table level is possible after the land has been elevated above the level of the permanent water table or after erosion has been sufficient to lower the permanent water table level. Either condition could bring the

Roger L. Spitznas

A typical siliceous geode, about seven inches in diameter, from the Tyson Creek locality.

geodes into the zone of the fluctuating water table and produce periods of alternating saturation and dehydration. It follows that when the geode-containing strata are above the water table oil might be introduced into the cavity after the water had withdrawn; and when, by rising, the fluctuating water table again brings the strata into the zone of saturation no oil will enter the geode because of the greater capacity of water to occupy pore spaces than the same capacity for oil. This also means that the oil which has reached the interior cavity of the geode will remain there as the condition, namely water saturation, which prevents its entry would also prevent its exit. Thus, with alternating periods of saturation below the water table and periods of dehydration after lowering of the water table, it would seem that the oil might be introduced either within one such alternation or during several such periods, be they seasonal or otherwise. The Tyson Creek locality is in such a topographic position that periods of alternations in the water table level might very well occur. A possible support to the fluctuating water table hypothesis is a commonly observed change in the material deposited within the geodes. Often specimens are found in which deposition of crystalline quartz has given way to deposition of chalcedony which now covers the old crystalline quartz. Such a change in mode of occurrence of silica might be caused by change in depositional conditions which may have resulted from water table fluctuation as described above. Whether or not this fluctuating condition of the water table would be true of all other geode locales is not certain, but free, untrapped oil must be present in the area experiencing the water table fluctuations for introduction of the oil into geodes to occur.

Without regard for the merit or demerit of hypotheses for the introduction of oil into geodes, the occurrence of oil and the less common minerals within geodes has kept interest and search for unusual occurrence active.

Strong Financial Backing Required For Ore Exploration

NEW YORK, May 29 (Science Service)—It is going to take a lot of money to discover new deposits of mineral ores to replace present deposits facing depletion, the United Nations Scientific Conference on the Conservation and Utilization of Resources (UNSCCUR) will be told at its meeting at Lake Success next August, it was revealed here today, by Dr. Anton Gray of the Kennecott Copper Corporation.

The day of the oldtime prospector, with pick and shovel and grubstake, is largely over. Only a financially strong company can carry out efficiently the search for hidden deposits, the international group will be told by Dr. Gray. Only a government can afford, under present conditions, to carry out adequately exploration for unknown mineral districts.

Mineral deposits for the most part have been found in groups, or districts, in which the individual deposits occur under the same geological conditions and usually contain more or less the same metals. There are, also, what are apparently isolated deposits, although if the truth were fully known many of these probably would not be isolated.

The possibilities of discovery, the costs and the methods that would apply to explorations for new districts differ greatly from those that apply to explorations within a known district. Searching for an extension to a known deposit, a new ore body, is an easier problem and one being solved continuously by every mining company in the normal course of its development. Dr. Gray expressed the opinion that in the near future most new mineral sources will result from the discovery of extensions to known deposits.

New mineral districts, he indicated, will most likely be discovered only as presently inaccessible parts of the earth are made accessible and under the incentive of greater need than we now have for the metals and higher prices for them.

No prospector could ever find these, no private company could afford to search for them with the methods and tools available today; and yet with increasing geological knowledge and better tools they might be found, he said. Such explorations will be taken only by or with the cooperation of, governments, and only as metals become very scarce and dear.

The Earth Sciences — 1949

Eden-Like Climate All Over Earth In Earlier Age Called A Myth

FRANK THONE

WASHINGTON, April 26 (Science Service) — Pictures of an earlier, Eden-like earth with a warm, balmy climate evenly distributed all over it and palm trees waving in the Arctic, were declared all wrong at the meeting of the National Academy of Sciences here, by Prof. Ralph W. Chaney of the University of California.

Fifty or sixty million years ago, in early Tertiary time, the climate of the whole earth was warmer than it is now, Prof. Chaney stated; but there was marked zonation just the same. Plant fossils collected in the Far North show that it had a temperate climate like that of the central and northern United States, while in what is now the Pacific Northwest conditions were subtropical.

In between these two great vegetational regions there was an intermediate zone. In this there were trees and shrubs representative of the regions on either side, but the dominant tree was the "dawn redwood" or Metasequoia, living representatives of which have recently been found surviving in China. Interestingly enough, the present Chinese Metasequoias also occupy an intermediate position, with cool-temperate trees to the north and warm-climate forests to the south.

The land bridge between North and South America now known as the Isthmus of Panama has been carrying two-way traffic for the past 5,000,000 years, Dr. W. P. Woodring of the U. S. Geological Survey told the Academy. The traffic at first was unevenly divided, with more animal migrants going south than there were going north, he added.

Fossil records show that the very first users of the bridge in both directions were small animals; and Dr. Woodring suggested that these did not even wait for the bridge to be completed, but made their way from island to island, "using still-separated spans and completed piers as stepping stones."

Thermoluminescence of Rocks May Give Better Radio-Activity Test

WATSON DAVIS

WASHINGTON, Apr. 27 (Science Service)—Energy from exploding atoms accumulated over millions of years can be stored in the earth's rocks and released usefully in a rush through a phenomenon explained to the National Academy of Sciences here.

Thermoluminescence, which is a giving off of light when material is warmed up, may also give a more sensitive test for radioactivity than a Geiger counter, Dr. Farrington Daniels of the University of Wisconsin explained in a paper prepared jointly with Drs. Charles A. Boyd and Donald F. Saunders.

Many rocks and minerals exhibit this property due to radioactivity through the ages caused by traces of the atomic energy elements, uranium and thorium. Dr. Daniels suggested that it might be possible to detect these elements through this method even when they were presented in less than one part in a million.

During the war radar images were stored on fluorescent mineral screens and made to appear when desired by heating them up by infrared "black" light.

Rhythms of heating deep in the earth's crust could be caused by trapped and stored radioactivity being released quickly by heat. This promises to give geologists a new way in which some rocks of the earth could be formed.

Fuel Oil Supply In America Will Last For Centuries

TULSA, Okla., May 9 (Science Service) — America will have a plentiful supply of fuel oil, including gasoline, diesel oil and heating oil, for centuries to come, the American Institute of Chemical Engineers was told here today by E. V. Murphree, E. J. Gohr and F. T. Barr of the Standard Oil Development Company of New York. Coal, oil shale and tar sands may be sources.

Deposits of oil shale and tar sands in the Western Hemisphere appear adequate to supply oil products at the present rate of consumption for at least 300 years, they declared. Figures indicate that there are reserves of coal and lignite in the United States above the needs of these fuels as such, which could be converted into oil products sufficient to last the United States for a great many years.

Present proven oil reserves of the world represent about 21 years' supply at the 1948 world oil consumption rate. It seems likely the oil that will be discovered in the future will represent a volume much larger than present proven reserves, and for this reason it is felt that the world's supply of oil products can be based on crude oil for many years ahead.

At the same time it is felt that improvements resulting from research on processes for converting natural gas, coal and oil shale into oil products will result in these raw materials representing a competitive source for oil products, they stated.

Alaskan Tin Deposits Described In Report

WASHINGTON, May 16—Wartime exploration of the Potato Mountain tin placer district near the tip of the Seward Peninsula in Alaska—one of the few places on the North American continent where tin has ever been mined commercially—is described in a report released today by the Bureau of Mines.

Between 1901, when stream tin deposits were found on Buck Creek, and 1920, the district produced about 1,500 tons of tin concentrate, the report says. Although production in the district had been negligible since 1920, previous operators were reported to have left an appreciable amount of tin. These reports, coupled with the strategic importance of the metal and the cutting off of the Nation's main sources of supply by the Pacific War, led the Bureau to examine the district in September, 1942.

The results of the examination were encouraging enough so that the Bureau began an investigation program, with two bulldozers and two placer drills, the following June. This work, a part of the program of mineral exploration authorized by the Strategic Materials Act of 1949, continued until September 22, 1943. In the course of the project, all the principal creeks in the district except Red Fox Creek were explored by drilling and trenching. In all, the report says, 256 drill-holes were sunk, totaling 2,880 feet.

The report describes the physical features and climate of the district, which lies 12 miles north of the Bering Sea and 9 miles south of the Arctic Ocean. The history and production of the area are outlined. The possibilities of obtaining an adequate water supply for placer operations are discussed. The report also describes the character of the placer deposits, as well as the placer workings. No lode tin of commercial grade has been found in the area.

A field party of the United States Geological Survey was in the area while the Bureau of Mines investigation was being carried out, and prepared maps included in the report. The publication also gives drill-hole logs.

A free copy of Report of Investigations 4418, "Investigation of Potato Mountain Tin Placer Deposits, Seward Peninsula, Northwestern Alaska," by Harold E. Heide and F. A. Rutledge, Bureau mining engineers, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

"Dawn Redwood" Pollen Found In Scottish Coal

EDINBURGH, May 16 (Science Service)—Trees like the recently discovered Chinese "dawn redwood" grew in Scotland between 30 and 50 million years ago.

Fossil pollen grains like those of the living Chinese tree have been found in coal mined in the town of Mull, states Dr. John B. Simpson of the Geological Survey Office here, in the British science journal, *Nature*.

The fossil pollen grains in the Mull coal are practically identical in shape, size and microscopic structure with pollen brought out of the Metasequoia forest in China. Dr. Simpson has not been able to find coal-embedded pollens resembling those of either the coast redwoods or the California big trees. Nearest things to his Metasequoia pollen grains, he notes, are two species of cypress, one found in China, the other in the United States.

Geology of The Andersonville Bauxite District, Georgia, Studied

WASHINGTON, May 25—A final report on the Andersonville bauxite district, Ga., has been released in open file for public inspection, Director W. E. Wrather of the U. S. Geological Survey announced today.

A geologic investigation of the Andersonville bauxite district in southwestern Georgia was made by the U. S. Geological Survey during 1942-1943, and a preliminary geologic map of the district was published in 1943. This investigation of the district was carried on under the joint auspices of the U. S. Geological Survey and the U. S. Bureau of Mines in the course of a nationwide wartime search for bauxite, the ore of alumina. More than 1,100 test holes were drilled, and over 3,000 samples were analyzed. The results of these investigations are summarized in this report.

The bauxite occurs as relatively thin, flat-lying bodies within larger lenses of sedimentary clays (kaolin) in the Nanfalia formation of the Wilcox group (lower Eocene), and most of it is under a thick overburden of late Eocene and Oligocene sediments.

This district contains slightly less than 6,000,000 long tons of bauxite with a minimum alumina content of 51 percent. The silica content of the ore ranges from 3.0 to 22.5 percent, and the iron content from 0.3 to 3.0 percent.

Under economic conditions existing in 1944, about 10 percent of this bauxite is located sufficiently near the surface for profitable mining. With the original Bayer process for the production of alumina it was not possible to use ore containing more than 7 percent silica. It is now practicable in some alumina plants to blend bauxite and bauxite clay that contain as much as 25 percent silica with low-silica bauxite to give an average silica content of 13 percent. Most of the ore in the district is being used in the chemical industry because of its relatively high silica and low iron content. A much greater tonnage of bauxite could be recovered if the large amount of kaolin and bauxitic clays that are associated with the bauxite could be exploited. The district may contain as much as 25,000,000 long tons of kaolin containing more than 37 percent alumina and less than 2 percent grit (quartz sand). Virtually none of the kaolin has been used.

The report, titled "Geology of the Andersonville bauxite district, Georgia," by Alfred D. Zapp, includes detailed logs of test holes, and geologic maps and sections. It may be examined by the public at Geological Survey offices, Room 1033 (Library), Federal Works Agency Building, Washington, D.C., and Room 13, Post Office Building, Knoxville, Tenn.; at the office of the Director, Georgia Department of Mines, Mining and Geology, 425 State Capitol, Atlanta, Ga.; and at the District Office, Soil Conservation Service, U. S. Dept. of Agriculture, Americus, Ga.

Old Faithful Geyser Still On 1870 Schedule

YELLOWSTONE PARK, Wyo., May 25 (Science Service) — Old Faithful, most famous of all geysers, is still performing on the same schedule it followed in 1870, when it was first carefully observed. It has the same interval between eruptions, plays to the same height, apparently discharges the same amount of water now as it did then.

Reports that the great natural hot-water spring is "losing its pep" simply aren't so, declares Dr. Philip F. Fix, formerly of the U. S. National Park Service and now of the U. S. Geological Survey. He based his declaration on many measurements and recordings which he himself made during a seven-year period of service in the Park, and on records made by several other observers covering a total of 78 years of Old Faithful history.

Average interval between eruptions, for the entire period, is 65 minutes, six and a fraction seconds, Dr. Fix states. This is quite close to figures obtained by half-a-dozen competent observers in the 1870's when the Park was new. There is not the slightest evidence that Old Faithful is slowing down, with eruptions becoming less frequent.

Old Faithful is not, and never has been, "as regular as a clock," despite earlier tall tales told to impress "dudes" from the East, he continues. There is always a slight irregularity in its timing, and sometimes the intervals between eruptions vary a good deal. Shortest interval on record was 34 minutes; longest authentically recorded lapse between eruptions was 91 minutes.

Height to which the column of hot water is thrown is difficult to determine, especially since different observers have used different methods. Estimated average heights therefore vary from 120 to 150 feet.

The volume of water discharged at each eruption has been much exaggerated in most estimates, Dr. Fix points out. A figure commonly given is 750,000 gallons per eruption; but this is many times too high. Fairly accurate gauging methods employed 20 years ago set a figure of from 10,000 to 12,000 gallons per eruption.

Details of Dr. Fix's observations are published in the April *American Journal of Science*.

Lightweight Geiger Counters Developed

OTTAWA, May 28 (Science Service)—A one-pound Geiger counter for uranium prospecting, developed by the Canadian National Research Council, together with several weighing from six to 11 pounds, will make possible a systematic search for this essential atomic energy mineral without the use of the much heavier Geiger counters now in use.

Radium and uranium prospecting before the war was largely a hit-and-miss affair, based principally on visual observation. Geiger counters eliminate the hit-and-miss method because this electronic instrument, now used for many years in detecting radioactivity, will register even trace amounts of radioactive substances. Several lightweight portable types have been developed since uranium has become so important in the atomic energy field, but none, as far as known, as light as the new Canadian one-pound, pocket-size instrument.

The Geiger-Mueller tube, the heart of the counter, is small in itself. Its power requirements at first were disproportionately large. Portable counters were made possible by the new miniaturizing techniques used in the construction of electronic circuits.

This Canadian miniature Geiger counter can be lowered by cable into a deep drill hole in a search for any radioactive material through which the hole might have passed. One of the steps which had to be taken was to overcome the interference of the cable itself which weakened and distorted the voltage pulse from the counter tube.

"Success came at last only recently when it was discovered that the resister coil in all circuits was needlessly large," the Council states, "and it was found that the power of the resister coil could be reduced to almost one-hundredth of its previous power."

Meetings and Conventions

Rocky Mountain Federation of Mineral Societies, Annual Convention. August 25-27, 1949. Albuquerque, New Mexico.

Midwest Federation of Geological Societies, 9th Annual Convention. August 26-28, 1949. Davenport, Iowa.

Fourth International Conference on Quaternary Research. August 22-September 15, 1949. Budapest, Hungary.

Northwest Federation of Mineralogical Societies, Annual Convention. September 2-4, 1949. Eugene, Oregon.

Geological Society of America, 62nd Annual Meeting; Paleontological Society, 41st Annual Meeting; Mineralogical Society of America, 30th Annual Meeting; Society of Vertebrate Paleontology, 9th Annual Meeting. November 10-12, 1949. El Paso Texas.

New Books

GEOLOGY, AN INTRODUCTION TO EARTH-HISTORY, by H. H. Read. 1949. 248 pp., 30 illus.; $2.00. (Oxford University Press, London, England).

This book begins with an interesting treatment of the evolution and development of geological principles. The sedimentary rocks are then thoroughly discussed, accompanied by a folder of the "Flow-sheet" for sedimentary rock production. The third chapter deals with igneous and metamorphic rocks. The author proposes to call all rocks related to volcanic activity **Volcanic rocks**, rather than igneous rocks, all the granitic and metamorphic rocks **Plutonic rocks**, and all the sedimentary rocks **Neptunic rocks.**

Earth revolutions and their causes are treated in the next chapter, with the emphasis on European folds. The Contraction, Convection Current, and Continental Drift theories are discussed. In the final chapter an excellent treatment of historical geology is found, particularly of Pre-Cambrian time and the Caledonian Revolution.

THE OCEAN, by F. D. Ommanney. 1949. 238 pp., 4 pls., 12 figs.; $2.00. (Oxford University Press, London, England).

A highly recommended book for the general reader, this "monograph in miniature" presents an outline of the physical characters of the ocean basin and sea-water, life in the sea, and the instruments and methods used in oceanography. Of particular interest is the chapter on the continental shelf, and the comprehensive discussion of the formation of coral reefs. In the final chapter the author gives a detailed discussion of oceanographic instruments such as the Nansen-Petterson bottle, described in the November 1948 **Earth Science Digest.** Amateur enthusiasts will find the hints for collecting, preserving and handling animals at sea especially useful.

BIBLIOGRAPHY OF NORTH AMERICAN GEOLOGY, 1946 and 1947, by E. M. Thom, Marjorie Hooker, and R. R. Dunaven. 1949. 658 pp.; $1.50. (U. S. Geological Survey, Washington, D. C.).

The Bibliography of North American Geology lists publications on the geology, paleontology, petrology, and mineralogy of the continent of North America and adjacent islands, Panama, the Hawaiian Islands, and Guam. It includes textbooks and general papers by American authors and those by foreign authors published in America. Sold by the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

GEOLOGY OF THE LAKE TITICACA REGION, PERU AND BOLIVIA (Memoir 36, The Geological Society of America, New York), by Norman D. Newell. 1949. 111 pp., 21 pls., 14 figs.; $5.00.

In this geologically complex area is the highest oil field in the world. The area is in the high plateau of the Central Andes, lying across the border between Peru and Bolivia. The sedimentary deposits total more than 20,000 meters, of which 7,000 meters of Lower Tertiary continental clastics comprise the largest part. There are two series of volcanic rocks: (1) a thick sequence of older folded and faulted rocks, and (2) a younger group of essentially horizontal beds. Six orogenic cycles are described. Pleistocene epeirogenesis is responsible for the present elevation of the Andes. The present topographic basin was caused by block faulting and stream erosion. Extensive horizontal lake clays rising topographically more than 100 meters above the present surface of the lake are interpreted as relics of a much more extensive ancestral lake.

GROUND WATER IN SOUTHWESTERN KANSAS, by John C. Frye and V. C. Fishel. 1949. 24 pp., 2 pls., 5 figs. (State Geological Survey of Kansas, Lawrence, Kansas).

Information on ground-water supplies in southwestern Kansas obtained during the past ten years is summarized. It contains a summary of the geology of the water-bearing rocks and of the source, quantity, and quality of water available.

SANDSTONE AS A SOURCE OF SILICA SANDS IN SOUTHEASTERN ONTARIO (Vol. LV, Part V, 56th Annual Report, Ontario Dept. of Mines, Toronto, Canada), by M. L. Keith. 1949. 36 pp., 11 illus.; free.

The area covered comprises parts of Frontenac, Leeds, and Lanark counties. Areas underlain by sandstone were delineated, potential quarry sites were selected and mapped, and occurrences were sampled. Laboratory investigations are described in the report. It is accompanied by a colored geological map showing the distribution of Potsdam Sandstone (Scale, 1 inch to 2 miles).

McCONNELL CREEK MAP-AREA, CASSIAR DISTRICT, BRITISH COLUMBIA (Memoir. 251, Geological Survey of Canada, Dept. of Mines and Resources, Ottawa, Canada), by C. S. Lord, 1948. 72 pp., 2 illus.; $0.25.

This report treats of the geology, structure, and economic features of the area. Mesozoic and Tertiary granitic inclusions are described, and noted for the first time in this part of the province is the presence of a large area of Upper Cretaceous and Paleocene strata. A belt of strong, post-Paleocene faults traverses the area from southeast to northwest. Many occurrences of gold, silver, copper, coal, and other minerals are of sufficient interest to warrant further search. A colored geological map on the scale of 1 inch to 4 miles accompanies the report.

AN UPPER EOCENE FORAMINIFERAL FAUNA FROM DEEP WELLS IN YORK COUNTY, VIRGINIA (Bulletin 67, Virginia Geological Survey, University, Virginia), by Joseph A. Cushman and D. J. Cederstrom. 1945 (1949). 58 pp., 6 pls.

An assemblage of foraminifera not hitherto reported from the northern Atlantic Coastal Plain was obtained from wells at the Navy Mine Depot, Yorktown, Virginia. The strata have not been recognized in outcrop and the new name given to the subsurface stratigraphic unit containing the fossils is the Chickahominy Formation. The character of the unit and its relations to the enclosing beds are described.

GEOLOGY OF MICHAUD TOWNSHIP (Vol. LVII, Part IV, 57th Annual Report, Ontario Dept. of Mines, Toronto, Canada), by J. Satterly. 1949. 28 pp., 12 illus.; free.

The lack of outcrops and the extensive deep overburden hinder exploration in this township. The underlying bed rock is all of pre-Cambrian age. The sediments are overlain by volcanics. A number of intrusives cut these rocks. The sediments and lavas have been highly folded and faulted. Economically valuable gold deposits are being sought and the results of diamond-drill campaigns "have been encouraging". The accompanying colored geological map is on a scale of 1 inch to 1,000 feet.

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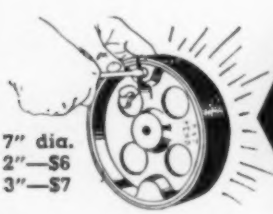

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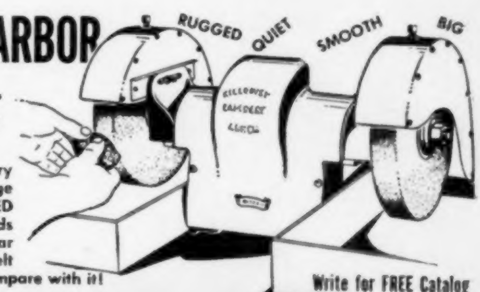

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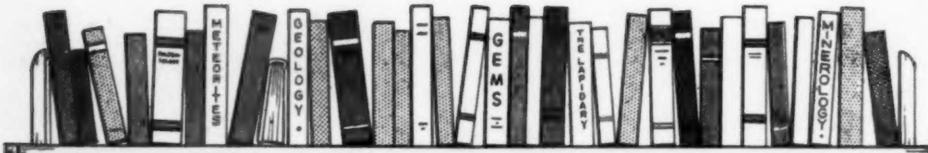

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